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NatureScaping™: An integrated framework to address modern world environmental challenges

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ABSTRACT

Environmental challenges such as biodiversity loss, ecosystem degradation, water insecurity, climate change and unsustainable land use are outcomes of interacting ecological, social, economic and institutional processes. Addressing these challenges requires planning approaches that consider landscape functions and human well-being together. This paper proposes NatureScaping™ as a place-based, science-informed and participatory framework for organising the assessment, planning, implementation and adaptive management of interventions in human-influenced landscapes. The framework is informed by six Rajasthan precedents documented through a combination of practitioner accounts, project materials and institutional conservation experience: the Abu Model; Chak Ramnagar/Project Boond-V; the Dholpur Model; Bharatpur–Keoladeo conservation and water-management experience; Rajputana's Shakuntalam; and nature-integrated planning associated with Vizrama Eco-Resorts. These precedents are treated as antecedent practices that informed conceptual development of the framework. NatureScaping™ proposes four assessment dimensions, namely ecological, social, economic and institutional and a seven-stage intervention cycle: LISTEN, MAP, RESTORE, INTEGRATE, EMPOWER, MEASURE and ADAPT. Eight potential application domains are identified, ranging from cities and watersheds to biodiversity corridors, campuses, hospitality, rural settlements and knowledge institutions. The framework is positioned as complementary to established approaches including ecological restoration, biodiversity conservation, Nature-based Solutions and integrated landscape management. Its potential alignment with selected Sustainable Development Goals and the Kunming–Montreal Global Biodiversity Framework is discussed as a planning opportunity rather than evidence of target achievement. The framework remains a conceptual and operational proposition requiring prospective pilot applications, standardised indicators, independent monitoring and comparative evaluation.

KEYWORDS

NatureScaping™; Landscape planning; Ecological restoration; Biodiversity; Water security; Nature-based solutions; Community participation; Adaptive management; Sustainable development

ARTICLE HISTORY

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Introduction

Environmental change is shaped by interacting pressures that affect ecosystem functioning and human well-being across landscapes. The IPBES global assessment identifies land- and sea-use change, direct exploitation of organisms, climate change, pollution and invasive alien species as the five major direct drivers of biodiversity change, operating alongside indirect drivers associated with demographic, economic, technological, institutional and cultural factors [1]. These drivers can interact and produce cumulative effects. For example, land-use change can alter habitat condition, landscape connectivity and hydrological processes; the nature and magnitude of these effects, however, depend on local ecological and socio-economic conditions.

International policy frameworks increasingly recognize the need to connect biodiversity objectives with spatial planning, ecosystem restoration and development decisions. The Kunming–Montreal Global Biodiversity Framework includes targets on participatory, biodiversity-inclusive spatial planning, ecosystem restoration, conservation and the integration of biodiversity into decision-making [2]. The first edition of the IUCN Global Standard for Nature-based Solutions sets out criteria and indicators for designing, assessing and improving interventions intended to address societal challenges while supporting biodiversity and human well-being [3]. Urban and territorial planning guidance published by UN-Habitat in 2025 also describes ways to integrate Nature-based Solutions, including green and blue infrastructure, into planning processes [4]. These instruments provide relevant policy and methodological context; they do not constitute validation of the NatureScaping™ framework.

Despite these developments, environmental interventions may still be planned and implemented through separate sectoral programs. Restoration, biodiversity conservation, water management, livelihood development, infrastructure and settlement planning may have distinct institutional responsibilities, spatial boundaries and monitoring systems. Coordination is therefore needed to examine interactions and trade-offs across land uses, stakeholders and scales. Integrated landscape approaches emphasize negotiation among competing land uses, multi-stakeholder processes and adaptive management rather than assuming that a single intervention can satisfy all objectives [5].

This paper proposes NatureScaping™ as a place-based, science-informed and participatory framework for organizing such integration. Its central principle is "Site Before Template": ecological and socio-economic conditions, local knowledge, institutional arrangements and landscape pressures should be assessed before interventions are selected. The framework does not claim to replace established environmental methodologies, nor does it introduce a new ecological restoration technique. Instead, it proposes an explicit planning and adaptive-management architecture through which established approaches may be selected, combined, monitored and adjusted according to place.

Aim and Objectives

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The aim of this paper is to present the conceptual foundations, operational structure and potential application contexts of NatureScaping™. The specific objectives are to: position the framework in relation to established environmental approaches; examine six Rajasthan field precedents that informed its development; describe its four assessment dimensions and seven-stage intervention cycle; identify potential application domains and alignment with selected global sustainability frameworks; and establish limitations and priorities for empirical evaluation [1–3,6,7].

Novelty and contribution

The proposed contribution is integrative rather than the invention of new ecological techniques. NatureScaping™ seeks to connect established methods within a common place-based planning and adaptive-management architecture. Its proposed value lies in making the sequence from contextual assessment to intervention coordination, participation, measurement and adaptation explicit, while bringing ecological, social, economic and institutional considerations into one planning structure. Whether this architecture offers practical advantages, improves coordination or produces better outcomes than existing approaches remains an empirical question requiring comparative evaluation.

Conceptual Foundations and Scientific Positioning

Landscapes as social–ecological systems

Landscapes can be analyzed as coupled social–ecological systems in which ecological processes, physical features, human activities and institutions interact. Vegetation, soils, water, species, built environments and livelihoods may influence one another across property and administrative boundaries. A landscape perspective is particularly relevant where environmental pressures, resource flows and management decisions extend beyond individual sites or sectors. Integrated landscape approaches seek to reconcile competing land uses through negotiated objectives, stakeholder coordination, adaptive management and attention to social, economic and environmental outcomes [5]. This perspective does not imply that all landscape components can be managed through a single intervention or that trade-offs can always be eliminated.

Relationship with ecological restoration

Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed. The Society for Ecological Restoration's second-edition principles and standards emphasize appropriate reference models, ecological recovery processes, stakeholder engagement, the use of multiple knowledge systems, measurable objectives, monitoring and adaptive management [6]. NatureScaping™ incorporates ecological restoration as one possible component within a broader landscape-planning process. It does not redefine ecological restoration, and not every NatureScaping™ activity should be described as restoration: some may concern conservation, sustainable management, planning, education or livelihood coordination without having ecosystem recovery as their primary objective.

Relationship with biodiversity conservation

Biodiversity conservation concerns the persistence and variability of life, including species, genetic diversity, ecosystems and the ecological processes that sustain them. Depending on context, conservation action may involve area-based protection, species recovery, threat reduction, habitat management, ecological connectivity and sustainable use. The Kunming–Montreal Global Biodiversity Framework provides a current international policy framework for biodiversity conservation and sustainable use, while the IPBES global assessment documents the major direct and indirect drivers of biodiversity change. Within NatureScaping™, biodiversity is treated as a central ecological consideration alongside water, soils, vegetation, livelihoods and governance. This integration must not dilute species-specific, habitat-specific or legally mandated conservation requirements [1,2].

Relationship with Nature-based Solutions

Nature-based Solutions (NbS) are actions to protect, sustainably manage and restore natural or modified ecosystems in ways that address societal challenges while providing benefits for human well-being and biodiversity. The IUCN Global Standard for Nature-based Solutions, first edition (2020), provides eight criteria and associated indicators concerning societal challenges, scale, biodiversity and ecosystem integrity, economic viability, inclusive governance, trade-offs, adaptive management and mainstreaming [3]. NatureScaping™ is proposed as a planning architecture through which NbS and other established approaches may be considered and coordinated in relation to site-specific conditions. It is neither an alternative NbS definition nor a certification or verification standard, and the use of the NatureScaping™ label alone does not demonstrate that an intervention meets the IUCN criteria.

Relationship with integrated landscape management

Integrated landscape management emphasizes coordination across land uses, sectors, stakeholders and spatial or administrative scales, often where productive activities and conservation objectives compete [5]. NatureScaping™ shares this landscape-level concern. Its proposed operational distinction is to articulate a seven-stage sequence—LISTEN, MAP, RESTORE, INTEGRATE, EMPOWER, MEASURE and ADAPT—and to organize assessment across ecological, social, economic and institutional dimensions. These features describe the framework's proposed structure; they do not establish that it is more effective, more comprehensive or more efficient than existing integrated landscape approaches. Such claims would require comparative implementation and outcome data.

Conceptual positioning

The comparison in Table 1 is intended to clarify relationships, not to establish that NatureScaping™ is a wholly separate discipline. Ecological restoration, biodiversity conservation, NbS and integrated landscape management are established fields or approaches with their own definitions, standards and evidence bases. NatureScaping™ is positioned here as a proposed integrative framework for deciding how relevant approaches may be assembled within a particular place, with attention to local ecological conditions, stakeholder priorities, institutional responsibilities and monitoring. Its distinctiveness therefore rests on the proposed organization of planning and adaptation, rather than ownership of the underlying methods. The framework's practical value remains

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to be tested through transparent pilot projects and comparison with existing approaches.

Table 1. Comparison of established environmental approaches and the proposed relationship of NatureScaping™.

Established approach	Primary emphasis	Proposed relationship to NatureScaping™
Ecological restoration	Recovery of degraded ecosystems	A possible intervention component, guided by restoration principles and reference models.
Biodiversity conservation	Species, habitats and ecological processes	A core ecological objective requiring context-specific and, where necessary, species-specific measures.
Nature-based Solutions	Ecosystem-based responses to societal challenges	An established approach that may be selected and coordinated where its criteria are met.
Integrated landscape management	Coordination across land uses, stakeholders and scales	A closely related landscape-level approach; NatureScaping™ proposes an explicit operational sequence, whose added value remains untested.

Four assessment dimensions

The framework proposes four interrelated assessment dimensions as a practical organizing device. The ecological dimension considers biodiversity, habitat condition, ecosystem processes, soils and water. The social dimension considers participation, access, cultural relationships, knowledge and distributional effects. The economic dimension considers livelihoods, resource use, costs, benefits and long-term maintenance. The institutional dimension considers mandates, governance, coordination, accountability and capacity. These dimensions are analytically distinct but interdependent: for example, an intervention may improve ecological condition while imposing unequal costs or creating long-term maintenance obligations. The four-dimension structure is proposed for assessment and planning; it is not presented as a validated measurement instrument and does not replace specialist ecological, social, economic, legal or statutory assessments.

Field-Based Precedents Informing the Framework

The six Rajasthan precedents are discussed as contextual antecedents that informed the development of NatureScaping™. They were not originally designed as applications of the seven-stage framework and should not be treated as a common experimental programme. Evidence quality differs among cases; practitioner-reported figures are identified as such and are not presented as independently validated causal outcomes. Their principal themes and evidence qualifications are summarized in Table 2.

Abu model: Biodiversity, livelihoods and stewardship

The Abu Hills nature-tourism experience links biodiversity conservation with community participation, local knowledge and livelihood opportunities.

Table 2. Comparative summary of the six Rajasthan field precedents and the evidentiary limitations of each case.

Precedent	Principal theme	Evidence qualification
Abu Model	Biodiversity, community engagement and livelihoods	Project-reported monitoring; established causal attribution.
Chak Ramnagar / Boond-V	Water access, community participation and local knowledge	Reported improvements; lacking continuous independent groundwater.
Dholpur Model	Water retention and productive landscape	As per monitoring records.
Bharatpur–Keoladeo	Wetland hydrology and biodiversity	Institutional and published context; distinct from Boond-V.
Rajputana's Shakuntalam	Eco-cultural stewardship and education	Practice-based precedent; through systematic outcome dataset.
Vizrama Eco-Resorts	Nature-integrated planning	Professional planning precedent; need to establish independent ecological outcomes.

The PANORAMA case account describes the initiative as a conservation-and-livelihood approach and identifies local youth, including former bird trappers and poachers, as participants in nature-guiding and conservation-related activities [8]. The same account reports fewer than 400 Green Avadavat individuals at ten monitoring sites in 2004 and more than 2,000 by the end of 2020. These are project-reported observations; the published account does not provide sufficient survey protocols, effort-standardization details, or independent population estimates to establish a statistically comparable population trend or causal effect of tourism. The species is identified as Vulnerable in pre-2026 conservation sources [9]. The 2026 Mount Abu habitat study is excluded under this paper's publication cut-off.

Chak Ramnagar and project boond-V: Water security and community participation

Project Boond-V was undertaken in Chak Ramnagar village during 2009–2010. The India Water Portal case account describes community mobilization, water-harvesting structures, pond and well works, awareness activities, and efforts to address unequal access to water. It reports that women travelled approximately three to five kilometres to obtain drinking water in 2009. The account subsequently records the recharged school well and a filled village pond following rainfall, while also describing the project's planned water-management measures [10]. This is a contemporaneous project case account, not a continuous, independently monitored groundwater series. Accordingly, the manuscript

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should describe the reported local water-access and infrastructure changes, not claim demonstrated long-term aquifer recovery. Mehra's account of community participation in water conservation provides a related practitioner source [11].

Dholpur model: Water retention and productive landscapes

The Dholpur precedent concerns water-retention and landscape interventions in a ravine-affected setting associated with the Bamani River and Chambal region. The project account available to the author describes a check dam and associated water-retention and livelihood interventions. However, the quantitative claims previously associated with this case have not been independently corroborated through an accessible engineering report, design calculation, or monitoring dataset. The case is therefore presented qualitatively and as a practitioner-reported precedent; no quantified hydrological or agricultural impact is inferred. Any future quantitative account should be supported by the underlying design, calculation and monitoring records.

Bharatpur–Keoladeo: Wetland hydrology and biodiversity

Keoladeo National Park provides an independently documented example of the relationship between water regimes, wetland habitat and biodiversity. A Wildlife Institute of India thesis assessed the park's hydrological functions and water budget, including its dependence on water supplied from structures within the wider watershed [12]. UNESCO World Heritage monitoring records also identify water supply reliability and invasive vegetation as important conservation-management issues [13]. Mehra and Mehra provide an additional peri-urban water and biodiversity perspective [14]. This case must remain analytically separate from Project Boond-V: evidence about Keoladeo hydrology does not establish that the Chak Ramnagar intervention caused changes in the park's bird populations.

Rajputana's Shakuntalam: Eco-cultural stewardship

Rajputana's Shakuntalam is presented as a practice-based precedent involving biodiversity stewardship, traditional resource-conservation perspectives and environmental education. The author-provided material supports its description as an illustrative initiative, but the public sources located for this audit do not independently establish its ecological activities, duration, governance arrangements or outcomes. It does not provide a systematic quantitative biodiversity or habitat dataset sufficient to establish restoration outcomes. The manuscript should retain this case only as a documented practitioner example and should cite a dated project record, site plan or institutional report if available.

Vizrama eco-resorts: Nature-integrated planning

Vizraama Resort is included as a professional planning and development context associated with Jhindoli/Rama near Udaipur. Publicly available company information identifies the resort enterprise and its location but does not independently verify ecological planning interventions or biodiversity outcomes [15]. In the absence of an approved site plan, ecological baseline or monitoring record, this case is treated only as an illustrative planning context—not as a completed or validated restoration outcome.

Comparative interpretation

Together, these precedents illustrate different entry points for integrated environmental thinking. They inform conceptual development but do not validate NatureScaping™. Their uneven evidence base also demonstrates why future applications require common baseline and monitoring protocols.

NatureScaping™ Conceptual Architecture

Definition and scope

NatureScaping™ is proposed as a place-based, science-informed and participatory framework for integrating ecological functions, biodiversity, water systems, soils, vegetation, built environments, communities and livelihoods within the planning and management of human-influenced landscapes. Where ecosystem degradation is identified and recovery is an explicit objective, ecological restoration may form part of the intervention portfolio; other applications may focus on conservation, sustainable resource management, spatial planning, environmental learning or livelihood coordination. The framework's defining operational proposition is to assess the ecological and socio-economic character of a place, identify its pressures and priorities, and then select and coordinate appropriate established interventions. Monitoring and adaptive management are intended to inform subsequent decisions. The framework is conceptual and has not yet been validated as a standardized assessment instrument.

Foundational principles

Site Before Template. Begin with the characteristics, histories, ecological processes, pressures, land uses and priorities of the particular place. Do not transfer a fixed intervention package without contextual assessment.

Ecological integrity

Consider biodiversity, ecosystem processes, habitat condition and ecological limits when setting objectives and evaluating trade-offs. Social or economic benefits should not be assumed to compensate automatically for unacceptable ecological harm.

Integration of human and ecological systems

Examine settlements, infrastructure, livelihoods, resource use and institutional arrangements alongside ecological processes, recognizing interactions across sites and scales.

Community participation and local knowledge

Identify affected rights-holders and stakeholders, provide meaningful opportunities to influence decisions, and document how local and Indigenous knowledge is considered. Participation should not be treated as a substitute for consent, rights protections or equitable benefit-sharing.

Use of established interventions

Select from established restoration, conservation, water-management, land-management and Nature-based Solutions methods according to site conditions, evidence, feasibility and applicable law. The framework does not replace technical standards or statutory approvals.

Measurable outcomes and accountability

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Define objectives, baselines, indicators, data sources, responsibilities, timeframes and reporting arrangements before implementation wherever feasible. Distinguish activities and outputs from ecological and social outcomes.

Adaptive management

Use monitoring and stakeholder feedback to review assumptions, identify unintended effects and revise interventions. Adaptation should be documented so that decisions can be evaluated over time.

Four-dimensional assessment

The four dimensions introduced in conceptual foundations and scientific positioning are applied here as complementary lines of inquiry rather than as a composite score.

Table 3. Four assessment dimensions and illustrative themes and evidence for site-specific assessment.

Dimension	Indicative Assessment Themes	Examples of Evidence
Ecological	Biodiversity, habitat condition, soils, vegetation, ecosystem processes	Field surveys, habitat mapping, species records, soil and water measurements.
Social	Participation, access, knowledge, cultural values, equity	Stakeholder mapping, interviews, participatory assessment, distributional analysis.
Economic	Livelihoods, costs, benefits, resource use and maintenance	Household or enterprise data, cost records, livelihood indicators.
Institutional	Mandates, coordination, capacity, accountability and continuity	Policy review, institutional mapping, agreements and responsibility records.

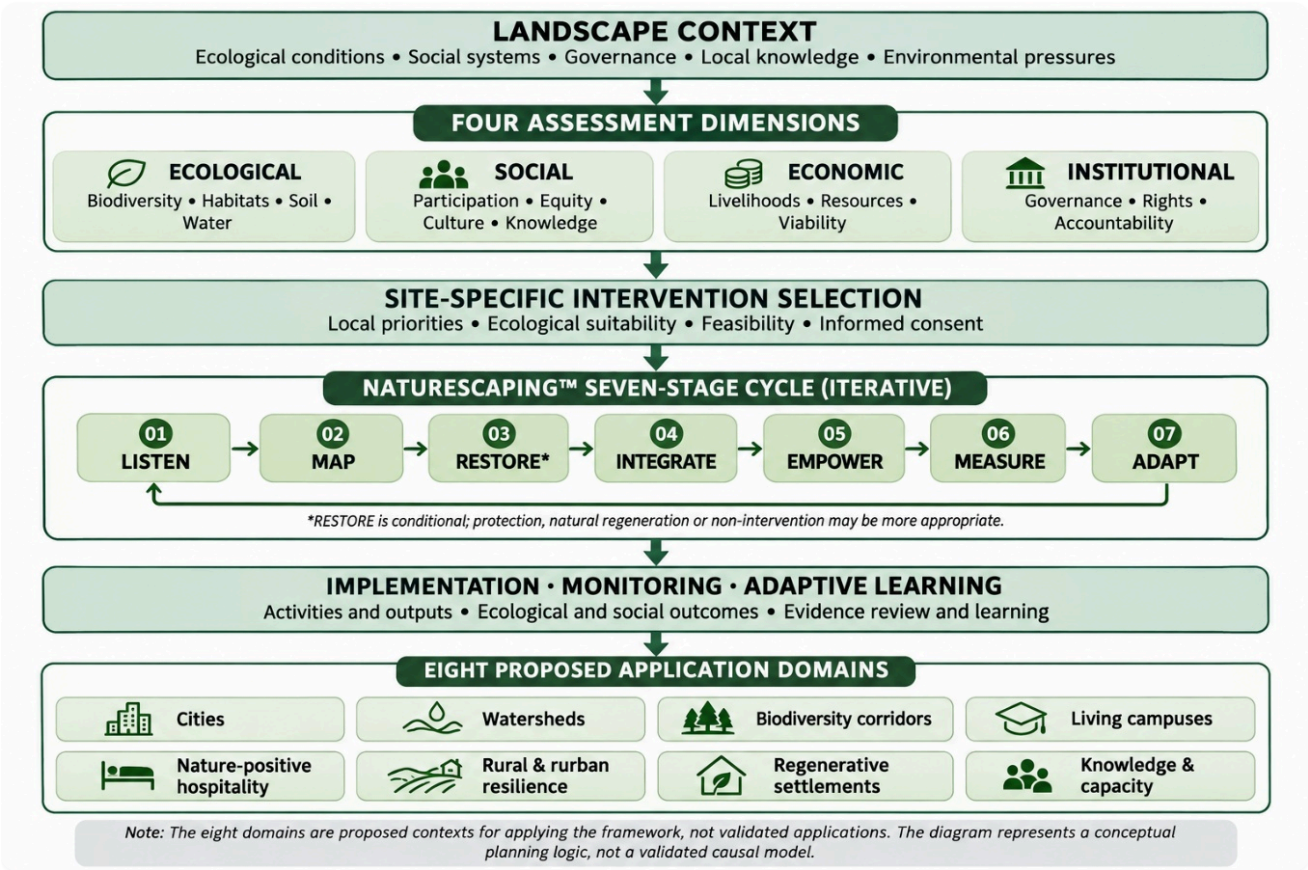

Figure 1. Proposed conceptual architecture of NatureScaping™.

The ecological assessment establishes the condition of habitats, species, soils, water and ecosystem processes; the social assessment considers stakeholders, rights, access, knowledge and distributional effects; the economic assessment examines resource use, costs, benefits, livelihoods and maintenance; and the institutional assessment maps mandates, decision-making, capacity and accountability. Assessment methods and indicators should be selected for the site and the stated objectives. A single aggregate score should not conceal trade-offs or substitute for specialist measurements. Indicative assessment themes and examples of evidence are summarized in Table 3. The integrated conceptual architecture is shown in Figure 1.

Architecture and results logic

The framework links landscape context and four assessment dimensions to site-specific intervention selection, an iterative seven-stage cycle, implementation and monitoring. The eight application domains are proposed contexts rather than

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validated applications. The diagram represents a conceptual planning logic, not a validated causal model.

The proposed results logic connects five linked elements: landscape context, pressures and stakeholder priorities; integrated baseline assessment; selection and coordination of interventions; implementation, producing activities and outputs; and monitoring of ecological, social, economic and institutional outcomes, followed by adaptation [1–3,6,7].

This is a planning logic, not an assumed causal chain. Contextual factors, external pressures and implementation quality can influence whether outputs lead to outcomes. Activities, outputs, outcomes and impacts must therefore be distinguished. For example, constructing a water-harvesting structure is an activity; its completed and technically verified storage capacity is an output; a sustained change in seasonal water availability may be an outcome; and longer-term changes in ecosystem condition or livelihood security may be impacts.

Three boundaries are important. First, NatureScaping™ is not a replacement for ecological restoration standards, conservation action plans, environmental impact assessment, statutory land-use planning or water and engineering standards. Second, the framework does not prescribe a universal intervention package: methods must be selected by qualified practitioners using site-specific evidence and legal requirements. Third, the use of its name or cycle does not itself demonstrate ecological improvement, social benefit, compliance with the IUCN Global Standard for Nature-based Solutions or contribution to a global target. Such claims require project-specific evidence.

Proposed application domains

Table 4. Proposed NatureScaping™ application domains and their illustrative planning focus.

Proposed Domain	Illustrative Planning Focus and Defining Context
Cities	Urban form and public realm: green-blue networks, urban biodiversity, heat and water management, equitable access.
Watersheds	Hydrological unit: catchment condition, seasonal water balance, soil conservation, recharge and downstream effects.
Biodiversity Corridors	Ecological connectivity: focal species, habitat quality, permeability, movement barriers and land-use compatibility.
Living Campuses	Institutional landholding: biodiversity, water, energy and resource use, learning landscapes and long-term stewardship.
Nature-Positive Hospitality	Visitor-oriented enterprise: site sensitivity, water and waste, habitat disturbance, visitor pressure and local livelihoods.
Rural and Rurban Resilience	Mixed rural–urban production and commons: water, agriculture, settlement change, livelihoods, biodiversity and tenure.
Regenerative Settlements	Settlement form and resource systems: built environment, ecological infrastructure, resource cycles and community governance.
Knowledge and Capacity	Learning and institutional capability: environmental education, local knowledge, research, training and monitoring capacity.

The eight domains are proposed contexts in which the framework may be explored, not established implementation outcomes or a closed classification of all possible landscapes. They describe potential application settings and may overlap. Terms such as “nature-positive” and “regenerative” are used as planning orientations only; they should not be interpreted as verified performance claims unless measurable criteria, baselines and evidence demonstrate the claimed condition. Their proposed planning focus is summarised in Table 4.

Proposed Seven-Stage Intervention Cycle

The seven-stage cycle is proposed as an iterative organising structure for planning and managing place-based interventions, not as a rigid or universally linear procedure. The stages describe linked functions that may overlap or recur as new evidence, stakeholder priorities or external conditions emerge. The sequence begins with engagement and contextual assessment, proceeds to the selection and coordination of appropriate interventions, and continues through monitoring and adaptation. RESTORE is not a compulsory instruction to undertake physical restoration at every site: the appropriate decision may instead be protection, improved management, threat reduction, or no intervention where action would cause harm. The sequence and key decision safeguards are illustrated in Figure 2.

Listen

Identify affected rights-holders and stakeholders; understand local priorities, knowledge, concerns and expectations; and examine differences in access, influence, interests and decision-making power. Document who is included and who may be absent from the process. The principal output is a stakeholder and engagement record that informs subsequent assessment and decisions.

Map

Establish the spatial, ecological, social and institutional context. Relevant information may include land use and land cover, habitats, species, water systems, soils, infrastructure, ownership or tenure, resource use, environmental pressures, hazards and institutional responsibilities. Record data sources, dates, scale, uncertainty and information gaps. The principal output is a baseline and landscape-context profile, including mapped constraints and opportunities.

Restore

Determine the appropriate response to identified ecological condition and pressures. Options may include avoiding damage, protecting intact ecosystems, reducing threats, assisting natural regeneration, undertaking active ecological restoration, rehabilitating degraded functions or choosing not to intervene. Where restoration is selected, objectives, reference conditions, methods and monitoring should follow recognised restoration principles and relevant technical standards. The principal output is a justified intervention decision with explicit ecological objectives; the decision may be that physical restoration is unnecessary or inappropriate.

Integrate

Coordinate selected interventions across ecological processes, land uses, infrastructure, livelihoods and institutional mandates. Identify dependencies, conflicts, trade-offs, cumulative effects and upstream–downstream relationships. Establish sequencing, responsibilities and coordination arrangements. The principal output is an integrated intervention plan that records expected synergies and unresolved trade-offs.

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Empower

Enable meaningful participation and strengthen the capacity of relevant stakeholders to influence decisions and implementation. Clarify roles, decision rights, consent requirements where applicable, access to information, grievance processes, maintenance responsibilities and benefit-sharing arrangements. Participation should be assessed by its influence on decisions, not simply by attendance. The principal output is an agreed governance and capacity arrangement, subject to applicable rights and legal safeguards.

Measure

Monitor implementation and changes against defined baselines, objectives and indicators. Distinguish activities, outputs and outcomes; document methods, sampling effort, data quality, uncertainty, frequency and responsible parties. Include unintended effects and distributional consequences. The principal output is a transparent monitoring record that can support interpretation and management decisions, rather than a claim of impact by itself.

Adapt

Review monitoring findings and stakeholder feedback and decide whether objectives, methods, responsibilities, timing or resource allocation should change.

Record the reason for each adjustment and retain a traceable decision history. Where evidence is insufficient, identify the additional information required rather than assuming success or failure. The principal output is a documented adaptive-management decision that feeds into renewed listening, mapping or intervention planning.

Decision gates across the cycle. At LISTEN, determine whose knowledge and rights must inform the process. At MAP, determine whether the baseline is adequate to make an intervention decision or whether further assessment is required. At RESTORE, justify the choice among protection, threat reduction, natural regeneration, active restoration, rehabilitation or non-intervention. At INTEGRATE, document trade-offs and responsibilities before implementation. At EMPOWER, confirm participation, governance and maintenance arrangements. At MEASURE, assess whether evidence is adequate to judge progress. At ADAPT, record whether to continue, modify, scale, pause or stop an intervention. These gates are proposed management prompts, not a validated decision-support protocol.

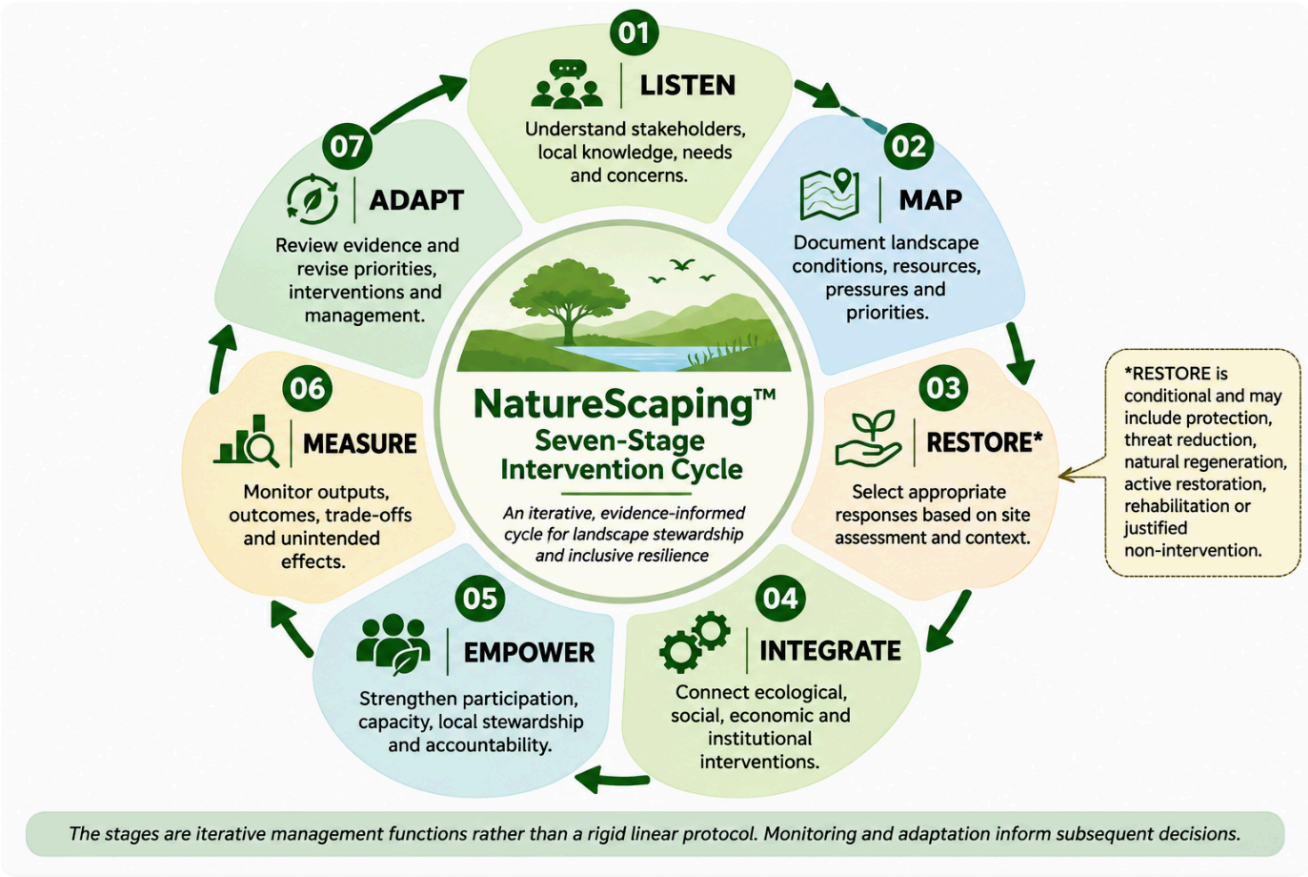

Figure 2. Proposed seven-stage NatureScaping™ intervention cycle.

The stages are iterative management functions rather than a rigid linear protocol. RESTORE is conditional on site assessment and may include protection, threat reduction, natural regeneration, active restoration, rehabilitation or justified non-intervention. Monitoring and adaptation inform subsequent decisions.

Monitoring and evaluation

Monitoring and evaluation should be designed during planning and before implementation wherever feasible. Each indicator should be linked to a stated objective, a baseline, a method, a sampling unit or population, a frequency, a responsible party and a data-quality procedure. Ecological measures may include habitat condition, species occurrence or abundance, vegetation structure, soil properties and water quality or availability. Social and institutional measures may

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include participation in decisions, access, distribution of benefits and costs, maintenance performance and governance continuity. Economic measures may include livelihood effects, costs, resource use and the durability of financing. Indicator selection must be site-specific; no single indicator set is appropriate for every landscape.

Activities, outputs, outcomes and impacts

The cycle requires a results chain that prevents activities or completed infrastructure from being reported as ecological or social impacts. An activity is an action undertaken; an output is a direct product of that action; an outcome is a measured change in condition or behaviour; and an impact is a longer-term effect that may require a stronger evaluation design. Claims about change should identify the baseline, time period, measurement method, data limitations and plausible alternative explanations. Causal attribution requires a suitable design, such as comparison sites or another defensible counterfactual where feasible, and should not be inferred from temporal coincidence alone.

Proposed Application Domains

The eight domains are proposed application contexts through which the framework's principles and cycle may be explored. They are not mutually exclusive landscape types, a hierarchy of priorities or evidence that NatureScaping™ has already been implemented successfully in each setting. Each domain requires a defined spatial and institutional boundary, site-specific objectives and an appropriate evidence base.

The domains are differentiated by their principal organising context: Cities and Regenerative Settlements focus on urban or settlement form; Watersheds on hydrological systems; Biodiversity Corridors on ecological connectivity; Living Campuses on institutional landholdings; Nature-Positive Hospitality on visitor-oriented enterprises; Rural and Rurban Resilience on mixed production, commons and settlement systems; and Knowledge and Capacity on learning and institutional capability. These distinctions are analytical conveniences, not exclusive categories.

Cities

Urban application may coordinate green and blue infrastructure, urban biodiversity, heat-risk reduction, water-sensitive planning and equitable access to public open space. Assessment should consider habitat quality and connectivity, local climate and hydrology, environmental justice, land-use pressures, public access and long-term maintenance. Urban greening should not be assumed to benefit all residents equally or to avoid displacement and other distributional effects.

Watersheds

Watershed application may coordinate catchment condition, soil and water conservation, riparian and wetland management, recharge, vegetation, agriculture and livelihoods. The relevant hydrological unit may extend beyond administrative boundaries. Assessment should consider seasonal water balances, upstream–downstream effects, environmental flows where relevant, water quality, competing uses and cumulative impacts; recharge or storage claims require appropriate measurement rather than inference from structures alone.

Biodiversity corridors

Biodiversity-corridor application requires evidence about focal species or ecological processes, habitat quality, landscape permeability, movement barriers and land-use pressures. Corridor boundaries should be justified using appropriate ecological and spatial data. A mapped or designated corridor does not by itself demonstrate functional connectivity, species movement or conservation effectiveness; these require suitable field or analytical evidence.

Living campuses

Campus landscapes may provide bounded settings for integrating biodiversity, water management, resource efficiency, environmental education and institutional stewardship. Potential actions include habitat management, native planting where ecologically appropriate, water-sensitive design and learning programmes. Evaluation should distinguish physical changes in campus condition from participation or educational outputs and should identify the institution responsible for maintenance and monitoring.

Nature-positive hospitality

Hospitality planning may consider site sensitivity, water demand, wastewater and waste management, habitat disturbance, visitor pressure, energy and material use, and relationships with local livelihoods and communities. The term "nature-positive" should be treated as an aspiration unless a credible baseline, measurable biodiversity outcomes, defined boundary and transparent accounting demonstrate a net improvement. Marketing claims alone are not evidence of positive ecological impact.

Rural and rurban resilience

Rural and peri-urban (rurban) settings may require coordination among agriculture, commons, water systems, biodiversity, settlement growth and livelihood strategies. Assessment should examine land and resource tenure, customary use, local institutions, access to common resources, distribution of costs and benefits, and links between rural production areas and expanding settlements. The term "rurban" should be defined consistently and used only where the setting genuinely combines rural and urban processes.

Regenerative settlements

Settlement planning may integrate built form, ecological infrastructure, water and material cycles, biodiversity, mobility and community governance. The term "regenerative" should be used as a stated planning objective, not as a demonstrated condition, unless the project defines measurable ecological and social criteria and reports performance against a credible baseline. Planning proposals should also be assessed against applicable development controls and environmental safeguards.

Knowledge and capacity

Educational and institutional settings may support environmental literacy, citizen monitoring, documentation of local and Indigenous knowledge, professional training and research partnerships. Knowledge documentation should respect consent, attribution, confidentiality where appropriate, community protocols and data governance. Participation or training counts are outputs; changes in knowledge, practice or environmental condition require separate evaluation.

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Cross-domain application

The domains may overlap. A watershed may contain villages, agricultural land, campuses, tourism facilities and biodiversity corridors; an urban area may also be part of a wider catchment. Each application should therefore define its primary spatial unit, the institutions with authority or influence within it, and the wider ecological or social connections that extend beyond the project boundary. The domain label should not replace an explicit description of site and scale.

Research requirements

Each domain requires prospective application and independent evaluation before claims of effectiveness or transferability can be made. Research should document site-selection criteria, baseline conditions, intervention logic, methods, costs, governance and maintenance responsibilities, trade-offs, unintended effects, and ecological and social outcomes. Transferability should be assessed as the adaptation of principles and decision processes to a different context, not replication of a fixed physical template. Comparative studies should explain what is being compared and account for differences in context and implementation.

Alignment with Global Sustainability Frameworks

Sustainable development goals

NatureScaping™ may provide a planning structure for identifying potential project-level relationships with selected Sustainable Development Goals (SDGs), where the project objectives and measured results are relevant. Potential links include SDG 2 where agricultural production and food systems are addressed; SDG 4 where environmental education and learning outcomes are evaluated; SDG 5 where gender equality and women's participation or benefit distribution are explicit objectives; SDG 6 where water availability, quality or water-related ecosystem management is addressed; SDG 8 where decent work and livelihood conditions are measured; SDG 11 where urban and settlement planning is involved; SDG 12 where resource use and waste are assessed; SDG 13 where climate adaptation or mitigation outcomes are evaluated; SDG 15 where terrestrial biodiversity and ecosystem condition are addressed; and SDG 17 where partnerships and institutional cooperation are documented. These are potential relationships, not automatic benefits of applying the framework. The 2030 Agenda for Sustainable Development provides the overarching policy framework [16]. Selected potential relationships and illustrative local measures are presented in Table 5.

Table 5. Potential relationships between selected Sustainable development goals and project-level measures.

Selected SDG	Potential relationship (only where within project scope)	Illustrative project-level measure (not an official global indicator)
2	Agroecology, sustainable production and soil/water management, where agriculture is included.	Soil condition; production diversity; water availability.
4	Environmental education and learning, where education is an explicit project objective.	Participation, learning outcomes and training continuity.
5	Gender equality, women's decision-making and equitable benefit distribution.	Representation in decisions; access to project benefits.
6	Water availability, quality, access and water-related ecosystem management.	Seasonal water availability, quality and reliability.
8	Decent work, livelihood security and nature-compatible employment.	Income sources, employment quality and distribution of benefits.
11	Inclusive urban planning, green-blue infrastructure and equitable public access.	Access to green space, habitat condition and heat-related indicators.
12	Material/resource efficiency, waste prevention and reuse.	Material flows, waste reduction and reuse.
13	Climate adaptation or mitigation, where climate risks and outcomes are assessed.	Exposure, sensitivity and locally relevant resilience indicators.
15	Terrestrial biodiversity, habitat condition, ecosystem restoration and sustainable use.	Habitat condition, species occurrence and restoration indicators.
17	Partnerships, institutional coordination and documented collaboration.	Joint plans, agreements, participation and reporting.

Kunming–Montreal global biodiversity framework

Selected targets of the Kunming–Montreal Global Biodiversity Framework (KMGBF) provide a biodiversity-specific policy context. Potential relevance includes Target 1 where participatory biodiversity-inclusive spatial planning is undertaken; Target 2 where degraded ecosystems are placed under effective restoration; Target 3 only where areas important for biodiversity are conserved and effectively managed through qualifying area-based measures; Target 4 where threatened species or genetic diversity are addressed through species-specific actions; Target 8 where climate adaptation or mitigation actions explicitly consider biodiversity; Targets 9 and 10 where sustainable use of wild species or biodiversity-friendly production systems are addressed; Target 11 where nature's contributions to people are assessed or enhanced; Target 12 where urban green and blue spaces and biodiversity-inclusive urban planning are relevant; Target 14 where biodiversity is integrated into policies and planning; Target 20 where capacity and technical cooperation are developed; Target 21 where data, information and knowledge are made accessible subject to safeguards and free, prior and informed consent for traditional knowledge; Target 22 where participation, access to justice and rights are relevant; and Target 23 where gender-responsive approaches and women's equal rights and representation are addressed [2]. The relevance of each target must be justified by the actual project scope and evidence. The selected target relationships and corresponding evidence considerations are

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summarized in Table 6. The potential relationship between the proposed framework and selected global frameworks is illustrated in Figure 3.

Relationships are conditional on project objectives, scope and evidence. The figure does not indicate target achievement, certification or compliance; project-level measures are distinct from official global indicators.

Interpretation and safeguards

The tables identify possible policy relationships, not target achievements.

Table 6. Potential relationships between selected KMGBF targets and project-level evidence requirements.

KMGBF target	Potential relationship (conditional on project scope)	Evidence needed at project level; not a substitute for official KMGBF indicators
1	Participatory, biodiversity-inclusive spatial planning and management.	Spatial plans, mapped pressures and documented decisions.
2	Effective restoration of degraded terrestrial or inland-water ecosystems.	Baseline, restoration area, ecological condition and monitoring.
3	Only where the project contributes to effective conservation/management of qualifying areas or OECMs.	Conservation status, management effectiveness and ecological outcomes.
4	Species-specific action for threatened species, or genetic-diversity conservation.	Species-specific surveys, threats and recovery measures.
8	Climate action with explicit biodiversity safeguards and resilience objectives.	Climate-risk assessment and measured ecosystem responses.
9–10	Sustainable management/use of wild species; sustainable agriculture, aquaculture, fisheries or forestry.	Resource-use data, production practices and biodiversity safeguards.
11–12	Measured nature contributions, ecosystem functions and services.	Ecosystem-service and equitable-access indicators.
14	Biodiversity-inclusive urban planning and urban green/blue space.	Evidence of biodiversity integration in plans and decisions.
20–21	Integration of biodiversity into policy, planning, assessment and development decisions.	Training, knowledge systems, data availability and use.
22–23	Capacity-building, technical/scientific cooperation and monitoring capability.	Representation, consent, rights safeguards and benefit distribution.

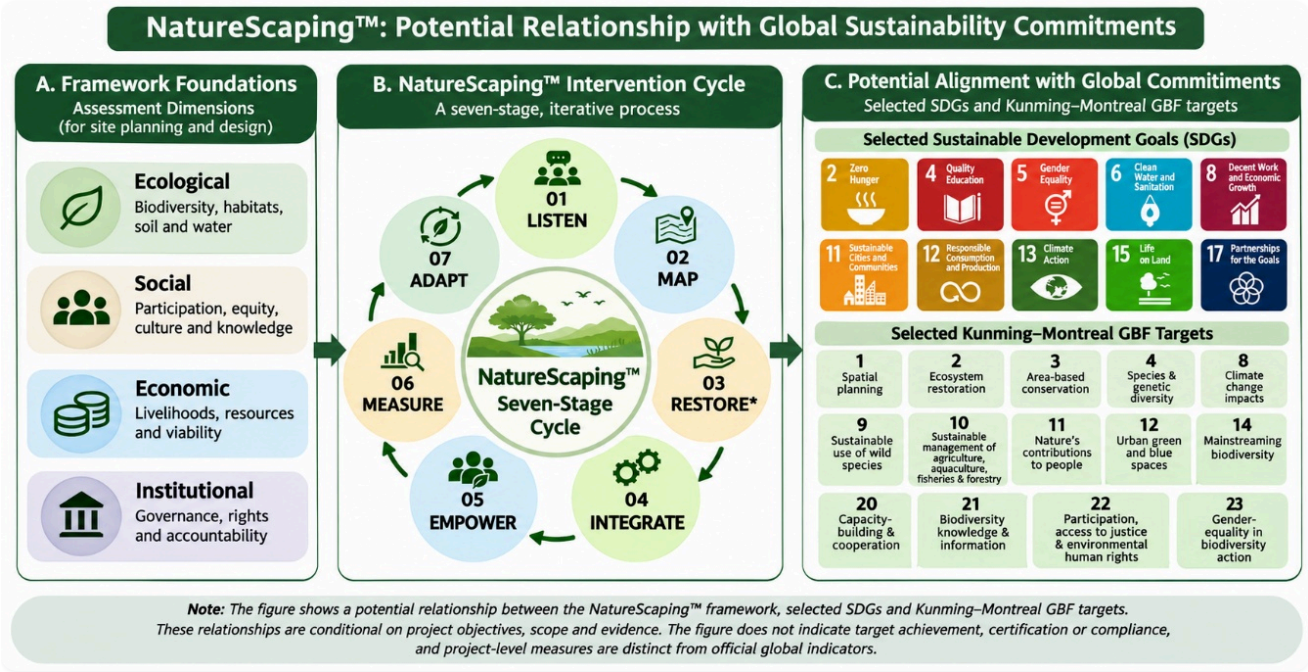

Figure 3. Potential relationship of NatureScaping™ with selected sustainable development goals and targets of the Kunming–Montreal global biodiversity framework.

The SDG global indicator framework and the KMGBF monitoring framework contain formally defined indicators and methodologies intended for global and national monitoring. Project-level indicators may be more locally specific and useful for management, but they must be labeled as such and must not be presented as substitutes for, or equivalent to, official indicators. A project should describe a contribution only where its activities and measured outcomes support that interpretation. Mere thematic alignment, participation in a programme or use of the

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NatureScaping™ label does not establish a contribution or achievement.

Monitoring and reporting

Projects applying the framework should identify relevant SDG goals, targets and KMGBF targets during planning, explain why each is relevant, and select local indicators linked to project objectives. They should record baselines, methods, timeframes, data sources, uncertainty and responsibilities. Where an official indicator methodology applies, the project should either follow that methodology or clearly distinguish its locally selected measure. For KMGBF reporting, the monitoring framework adopted in 2025 should be consulted alongside national biodiversity strategies, national targets and reporting arrangements [2]. Project reports should avoid aggregating unrelated local indicators into a single claim of global target progress.

Discussion

The proposed NatureScaping™ framework addresses a coordination challenge in landscape-level environmental management. Ecological restoration, biodiversity conservation, water management, livelihood development and settlement planning have distinct objectives, technical methods and institutional responsibilities. Where these activities occur within the same landscape, decisions in one sector may affect the options and outcomes available to another. The framework proposes a common planning architecture through which ecological, social, economic and institutional considerations can be examined together. Its contribution is therefore organizational and integrative, rather than the introduction of a new environmental technique.

This positioning is consistent with landscape approaches that recognize interactions among land uses, stakeholders and ecological processes [5]. However, the existence of a coordination challenge does not by itself demonstrate that a new framework is required or that the proposed framework will resolve it. NatureScaping™ should therefore be evaluated against the planning and management processes already available in each setting. Its potential usefulness will depend on whether it clarifies responsibilities, improves the use of evidence, makes trade-offs more visible or supports more coherent monitoring without creating unnecessary procedural complexity.

The principle of "Site Before Template" expresses the framework's central decision rule: interventions should follow an assessment of the particular place rather than the automatic transfer of a standard package. This principle is not unique to NatureScaping™; it is consistent with established place-based and adaptive approaches. The proposed contribution is to make the sequence from listening and mapping through intervention selection, coordination, participation, measurement and adaptation explicit. The seven stages should be understood as linked management functions, not as a claim of methodological novelty in each individual activity.

The framework's relationship with established approaches is complementary. Ecological restoration may be selected where recovery of degraded ecosystems is an objective; biodiversity conservation may guide species- and habitat-specific priorities; Nature-based Solutions may address societal challenges through ecosystem protection, sustainable management or restoration; and integrated landscape management may support coordination among competing land uses. NatureScaping™ proposes a structure for considering such approaches in relation to site conditions and stakeholder priorities. It does not replace their definitions, technical standards, statutory requirements or evaluation methods. Whether the proposed sequence adds practical value is an empirical question.

The six Rajasthan precedents provide contextual examples of the types of practice and experience that informed the framework. Their evidentiary value is not uniform and they should not be treated as a comparative sample or as validated NatureScaping™ applications. The Abu population figures are project-reported observations without sufficient information to establish causal attribution; the Chak Ramnagar account documents reported water-access and infrastructure changes but not a continuous independent groundwater series; Dholpur's numerical claims require primary engineering and monitoring records; and Keoladeo's institutional hydrological evidence concerns a separate wetland context. Shakuntalam and Vizrama remain illustrative practice or planning examples without systematic independent ecological outcome datasets in the material reviewed. These limitations constrain the conclusions that can be drawn from the precedents but do not prevent their use as clearly labeled sources of conceptual learning.

The precedents also illustrate why a common assessment protocol is needed if future applications are to be compared. Different project objectives, timeframes, spatial boundaries and monitoring methods make direct comparison unreliable. Future case documentation should state the intervention boundary, baseline, implementation period, responsible institutions, indicators, data sources and limitations. Where these elements are unavailable, the manuscript should report descriptive experience rather than infer ecological or social impact.

Community participation is relevant not merely as a means of securing implementation, but as a question of decision-making, rights and distribution. Consultation or attendance does not demonstrate meaningful influence. Assessment should consider whose knowledge is recognized, who defines priorities, who bears costs, who receives benefits, and whether affected rights-holders can influence decisions. Local and Indigenous knowledge may provide important contextual insight, but its use requires appropriate consent, attribution and governance. Such knowledge should complement, rather than replace, specialist ecological and technical assessment.

Monitoring is central to the proposed architecture because it links stated objectives to evidence and subsequent decisions. Baselines, indicators, sampling methods, frequency, responsibilities and data-quality procedures should be established before implementation wherever feasible. Reporting should distinguish activities and outputs from outcomes and impacts, describe uncertainty and consider external influences. Independent evaluation or comparison sites may strengthen inference where feasible, but the appropriate design will depend on the intervention, scale, timescale and available resources. A monitoring system should be proportionate and useful for decisions rather than an administrative exercise.

The proposed links with the SDGs and KMGBF offer a way to situate project objectives within wider policy commitments. They do not confer certification, establish compliance or demonstrate global target achievement. Project-level

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contributions should be reported only where the relevant target is within scope and evidence supports the relationship. Likewise, transferability should be understood as the adaptation of principles and decision processes to local ecological, cultural, tenure, regulatory and institutional conditions, not as replication of a fixed intervention package.

NatureScaping™ may be useful to practitioners, planners, institutions and researchers when a landscape requires coordination among multiple interventions and stakeholders. Its value remains to be demonstrated. Prospective pilot applications and independent comparative research should examine whether it improves planning coherence, transparency, accountability, ecological condition or social outcomes relative to existing processes. Research should also document additional costs, implementation burdens, unsuitable contexts and unintended consequences. Evidence that the framework adds little value in particular settings should be reported alongside positive findings [17,18].

Limitations and Research Agenda

Limitations of the available evidence

The six field precedents differ in objectives, geographical and ecological settings, implementation histories, spatial boundaries and documentation. They were not originally conceived as applications of NatureScaping™ and were not implemented using a common assessment methodology. Their inclusion provides contextual and practice-based insights rather than comparative evaluation. Evidence is uneven: some examples have institutional publications or published research, while others rely mainly on practitioner records and professional descriptions. Project-reported figures should not be presented as independently validated outcomes without supporting datasets, protocols or third-party assessment. The cases were selected partly because of their relevance to the practitioner's experience and the development of the concept; they should not be interpreted as a representative or exhaustive sample of environmental practice in Rajasthan.

The available documentation does not provide a consistent set of baseline and post-intervention observations across all six precedents. This limits assessment of the magnitude, duration, distribution and attribution of reported changes. The manuscript also draws substantially on practitioner experience associated with concept development, creating potential risks of selection, recall and interpretive bias. Some project records may be unpublished or not independently accessible, limiting reproducibility and external scrutiny. These limitations should be addressed through transparent source documentation and independent assessment rather than by treating narrative accounts as equivalent to measured outcomes.

Limitations of the proposed framework

NatureScaping™ remains a proposed conceptual and operational framework rather than an empirically validated methodology, standard or certification system. Its seven-stage cycle, four assessment dimensions and eight proposed application domains have not been tested systematically across multiple landscape types. The framework does not yet provide validated minimum protocols, indicator definitions, scoring rules, decision thresholds or procedures for resolving conflicting objectives. It therefore cannot currently support standardized performance ratings or claims of comparative effectiveness. Technical methods for ecological surveys, hydrological assessment, biodiversity monitoring, stakeholder engagement, livelihood evaluation and institutional analysis must be selected by competent practitioners according to site conditions, objectives and applicable standards.

Implementation may require substantial time, finance, specialist expertise, facilitation, data infrastructure and inter-agency cooperation. These requirements may be difficult to meet where governance is fragmented, tenure is insecure, resource claims compete or institutional capacity is limited. Integration can also create transaction costs and additional coordination burdens. Interventions may generate trade-offs across species, habitats, water users, livelihood groups and generations; the framework does not yet contain a tested method for weighting or resolving such trade-offs. The eight proposed application domains may therefore differ considerably in feasibility and suitability, and some settings may not benefit from adopting the full framework.

Research priorities

Research should proceed in a staged and independently reviewable manner. First, a protocol-development phase should define the framework's terms, spatial boundary rules, minimum documentation requirements, decision gates, stakeholder safeguards and reporting format. Second, prospective pilot studies should be selected using transparent criteria and should document baseline ecological, social, economic and institutional conditions before implementation. Third, monitoring protocols should specify indicators, methods, sampling units, frequency, data quality, responsibilities, costs and uncertainty. Fourth, independent evaluation should assess implementation fidelity, feasibility, coordination, equity, unintended effects and measured outcomes. Where feasible, comparison sites, before–after designs or other defensible counterfactual approaches should be used; the design must be proportionate to the intervention and should not imply causal inference where the data do not support it. Fifth, cross-site synthesis should identify which principles and stages are transferable, which require adaptation and where the framework is unsuitable. Results, including null or adverse findings, should inform revision.

Proposed research questions

Does the seven-stage cycle improve coordination, transparency or accountability compared with the planning and management processes already used in comparable settings?

What minimum baseline information, indicators and monitoring frequency are feasible and sufficient for different landscape types and intervention objectives?

Under what governance conditions do participation, rights recognition and local knowledge influence decisions and contribute to equitable distribution of costs and benefits?

What ecological, social and economic trade-offs arise from different combinations of interventions, and how are these trade-offs identified and managed?

Which components of the framework can be transferred across ecological and institutional contexts, which require modification, and which should not be applied?

What are the financial, institutional and administrative costs of using the framework, and do any demonstrated benefits justify those costs?

Proposed validation pathway

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A phased validation pathway is proposed. Phase 1—Protocol specification: define terminology, principles, spatial boundaries, stage-specific tasks, decision gates, minimum evidence requirements, stakeholder safeguards and reporting templates. Phase 2—Prospective pilots: select sites transparently across more than one ecological or institutional context; document baseline conditions and register objectives and indicators before implementation. Phase 3—Implementation and monitoring: record activities, outputs, outcomes, costs, responsibilities, uncertainty and unintended effects using documented methods. Phase 4—Independent evaluation: assess feasibility, implementation quality, participation, equity, ecological and socio-economic results, and limitations; use comparison or counterfactual designs where appropriate and feasible. Phase 5—Cross-site synthesis and revision: compare results, identify context-dependent elements and revise the framework in light of positive, null and adverse findings. This sequence is a proposed research programme; no phase of framework validation is claimed to have been completed.

Implications for further development

The present paper offers a conceptual basis for NatureScaping™ by connecting established environmental approaches, practitioner experience and a proposed operational cycle. The evidence presented is sufficient to explain the framework's rationale and its antecedent practices, but not to establish effectiveness, superiority or transferability. Further development should prioritize transparent methods, independent scrutiny, community accountability and measurable ecological integrity.

Conclusion

Environmental challenges in human-influenced landscapes involve interacting ecological processes, land uses, infrastructure, livelihoods and institutional arrangements. Established approaches—including ecological restoration, biodiversity conservation, Nature-based Solutions and integrated landscape management—provide important methods for addressing these challenges. Their coordinated application, however, requires attention to place-specific conditions, competing priorities and responsibilities across sectors and stakeholders.

This paper proposes NatureScaping™ as a place-based, science-informed and participatory framework for organizing that coordination. Its "Site Before Template" principle places contextual assessment before intervention selection. The proposed architecture combines four assessment dimensions —ecological, social, economic and institutional—with an iterative seven-stage cycle: LISTEN, MAP, RESTORE, INTEGRATE, EMPOWER, MEASURE and ADAPT. The cycle is intended to organize decision-making and adaptive management; it is not a validated technical protocol or a prescribed package of interventions.

Six Rajasthan precedents are discussed as contextual practices that informed the framework's development. They differ in their documentation and evidence quality and were not originally implemented as NatureScaping™ projects. They therefore provide illustrative practitioner and institutional experience, not validation or comparative evidence of framework effectiveness. The eight application domains are likewise proposed contexts for future exploration, not demonstrated applications.

NatureScaping™ is not intended to replace established environmental methodologies, technical standards, statutory processes or specialist assessments. Its proposed contribution is an organizing architecture for considering established approaches together, selecting interventions in response to local conditions, and linking implementation to monitoring and adaptation. Potential relationships with the SDGs and the Kunming–Montreal Global Biodiversity Framework are opportunities for project-level planning and reporting; they do not establish compliance or target achievement.

The framework's practical and scientific value remains to be tested. Prospective pilot applications should establish transparent baselines, document intervention choices and trade-offs, use appropriate ecological and socio-economic indicators, and report uncertainty and unintended effects. Independent evaluation and comparative research should determine whether the framework improves planning coherence, accountability or landscape outcomes relative to existing processes, and identify contexts in which it may be unsuitable. Until such evidence is available, NatureScaping™ should be understood as a proposed integrative framework whose further development depends on methodological transparency, ecological integrity and community accountability.

Generative AI Disclosure

Generative artificial intelligence (AI) was used as an assistive tool during the preparation and revision of this manuscript. ChatGPT (OpenAI; GPT-6) was used during the 2025 revision process to assist with restructuring and organizing sections, drafting and refining explanatory prose, improving language and readability, and identifying claims, references and case-study details requiring further author verification. AI outputs were treated as drafting and editorial assistance only, not as independent evidence, field observations, data or authoritative bibliographic records. The author is responsible for checking all factual statements, references, quotations, interpretations and project information against original sources; correcting or removing unsupported material; reviewing the complete revised manuscript; and approving the submitted version. The author retains responsibility for the manuscript's content, conclusions and compliance with publication ethics.

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